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CASE REPORT

Surgical Treatment of Distal, Extracranial, Internal Carotid Artery Aneurysms Involving the Base of the Skull – a Multidisciplinary Approach

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Introduction

Aneurysms of the extracranial internal carotid artery (ICA) are uncommon. The most frequent aetiology is atherosclerosis, most often affecting the bifurcation of the common carotid artery, whereas spontaneous or post-traumatic dissection mainly affect the distal portion of the ICA.[1] These lesions usually present with symptoms of transient ischaemic attacks from emboli, cranial nerve dysfunction or local expansion. Rupture with haemorrhage is rare.

The main indications for operative treatment are cranial nerve deficits and preventive surgery for catastrophic embolic complications. Surgical treatment of the most distal aneurysms, involving the base of the skull, is a challenge, due to the difficulty of exposure of the distal ICA without interference with nearby structures and re-establishment of arterial continuity. This report summarises the surgical experience with these lesions where a multidisciplinary team consisting of neurosurgeon, otological surgeon and vascular surgeon is involved.

Operative Technique

Preoperative investigations include CT of the neck, aorto-cervical arteriogram and selective ICA arteriogram. The tolerance for peroperative temporary ICA clamping is assessed preoperatively by balloon occlusion of the ICA. During this procedure the patient is carefully monitored for neurological signs and hemispheric blood flow is measured using SPECT.

The surgical procedure is performed using neuroprotective technology including moderate hypothermia (33 °C), mannitol and barbiturate administration. The surgical strategy aims at excluding the aneurysm from the circulation and re-establishing distal flow to the brain. Exposure of the intrapetrosal part of the ICA allows access to normal artery wall distal to the aneurysm.

An incision in the neck, made along the anterior margin of the sternocleidomastoid muscle is extended retroauricularily, sometimes continuing into a craniotomy incision. The bifurcation of the common carotid artery is exposed and secured.

Continuous monitoring of the facial nerve is used during the operation to avoid traumatization. A mastoidectomy is performed, including posterior tympanotomy with skeletonising of the vertical segment of the facial canal. The tip of the mastoid is reflected posteriorly together with the sternomastoid muscle. The tympanic bone under the ear canal is removed by drilling, exposing the jugular foramen and the carotid canal. The inferior portion of the bony external ear canal is removed using reciprocating saw. The ear canal skin and the lower portion of the tympanic membrane are folded upward, maintaining the ossicles *is situ*. Facial nerve dissection is extended along the peripheral part of the nerve into the parotid gland, and the nerve is transposed anteriorly. The carotid canal is opened widely by further drilling, exposing the intrapetrosal carotid artery. A complete removal of the ear canal and the middle ear together with exenteration of the bony part of the Eustachian tube widens the exposure in patients with narrow anatomical conditions.

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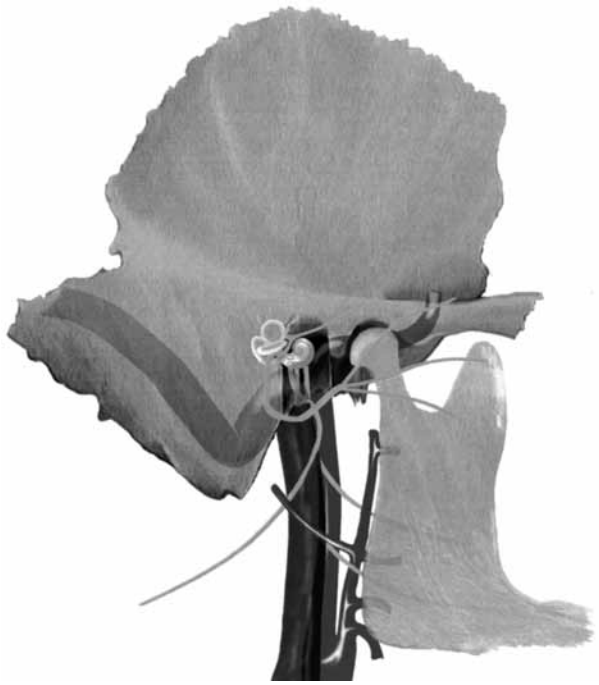

Fig. 1. Schematic rendering illustrating the close anatomical relationships in the temporal bone with the inner ear labyrinth, jugular bulb, temporal portion of the ICA, and cranial nerves 7 through 12.

Fig. 2. This figure illustrates the mastoidectomy and how the vertical section of the intratemporal ICA is exposed cranial to the high ICA aneurysm. A vein graft bypass is then anastomosed end-to-side from the proximal ECA to the exposed intratemporal ICA at a level indicated by the position of the facial nerve, which is transposed anteriorly to gain access. The aneurysm if excluded from the circulation by proximal and distal ligation.

The aneurysm is by-passed with a saphenous vein graft. The intrapetrosal portion of the artery distal to the aneurysm is clamped during the end-to-side anastomosis of the vein graft using a temporary clip. At this anatomical level the arterial diameter is too narrow to allow passage of a standard carotid shunt. After back flow flushing, the proximal end-to-side anastomosis to the external carotid artery is completed and the internal carotid blood flow is re-established. The aneurysm is excluded with proximal ligature and a distal clip and evacuated. In order to avoid injury to the hypoglosseal, glossopharyngeal and vagal nerves, no attempt is made to remove the aneurysm (Figs 1 and 2). The resected bony ear is reinserted allowing the ear canal skin and the tympanic membrane to return to their normal positions.

Postoperative monitoring includes transcutaneous pO_2-monitoring of the cerebral circulation (NIRS) and control of by-pass patency using duplex technique.

Case Reports

Case 1

A 54-year-old previously healthy woman was admitted to the hospital with a few weeks' history of a tender, palpable mass in the right side of the neck and episodes of dysphagia. The mass bulged into the paratonsillar region and reversible paralysis of the glossopharyngeal and hypoglossal nerves could be provoked by extending the neck. No audio-vestibular symptoms were present. The preliminary diagnosis was a tonsillar abscess. A CT scan of the neck revealed an 80 mm aneurysm filled with a thrombus that involved the distal portion of the right ICA. No normal artery was seen below the base of the skull, and this was verified by selective ICA arteriography. Test balloon occlusion of the internal carotid during 15 min caused paraesthesia in the left arm and the hemispheric blood flow decreased by 30% as evaluated by SPECT.

Due to narrow anatomical conditions it was necessary to remove the entire ear canal and the middle ear while preserving the inner ear structures. The temporomandibular joint was opened and the mandible was displaced anteriorily during the operation.

Temporary facial nerve paralysis was the only postoperative complication. Postoperative Duplex sonogram verified a normal by-pass function and selective arteriography confirmed patency of the graft 3 months later.

Case 2

This was a 39-year-old man with a 6-month history of headache, otalgia and tinnitus in the left ear. Left-

sided Horner's syndrome developed over time and he experienced two episodes of possible transient ischaemic attacks. A 3 cm left-sided ICA aneurysm that reached distally into the carotid canal in the skull base was disclosed with CT scanning and arteriography. A test balloon occlusion was well tolerated. The aneurysm was trapped and bypassed with vein graft from the external carotid artery using a vein graft. Postoperatively transient palsy of the 7th, 9th and 10th cranial nerves was present. Hearing returned to normal 1 month postoperatively. Patency of the graft was verified with duplex sonography.

Case 3

A 57-year-old male had suffered an attack of sudden headache, dysphagia and hoarseness 4 months prior to referral to our centre. During that time span atrophy of the left trapezius muscle and the left side of the tongue developed and on examination the left vocal cord and left side of the pharynx were also found to be paralysed. A 3 cm aneurysm on the left ICA was demonstrated. The ICA was tortuous, with a siphon-like formation at the inflow to the aneurysm. Carotid balloon occlusion testing was refused by the radiologists. The artery was dissected from the aneurysm wall. In this case enough ICA length was gained to permit direct end-to-end anastomosis of the ICA with exclusion of the aneurysm. Intraoperative EEG monitoring showed no signs of hemispheric ischaemia during carotid occlusion. Patency of the bypass was verified four months postoperatively. The cranial nerve palsies did not improve except for the facial nerve, which recovered after a transient facial paralysis. Hearing returned to normal level postoperatively.

Discussion

Aneurysms of the extracranial carotid arteries are rare lesions and not uncommonly bilateral.[2] The sex ratio is approximately equal. ICA and the common carotid artery are involved at approximately the same frequency, whereas involvement of the external carotid artery is exceptional.[3]

Proximal ICA aneurysms are more frequent in patients over 50 years of age with a predominant atherosclerotic etiology. Conversely, distally located ICA-aneurysms are encountered in all age groups and a variety of causes have been described (trauma, congenital defects, fibromuscular dysplasia, infection, spontaneous dissection).[4] The diameter of distal ICA aneurysms are reported between 2–5 cm.[5] In our cases the lesions were between 3–8 cm.

The clinical features encountered in our cases were similar to those described in other reports with a cervical mass, cranial nerve dysfunction, cervical mass and cerebrovascular embolic episodes as major manifestations.[6] Computerised tomography detects the aneurysm well, whereas arteriography sometimes fails to visualise the aneurysm due to intramural thrombus formation.[4]

The natural history of the distal ICA aneurysms is not well known. Winslow[7] reported 71% mortality in non-operated aneurysms. Mortality after proximal carotid artery ligature is high (30%). An uneventful test balloon occlusion of the ICA cannot fully exclude the risk for stroke with permanent ligation of the ICA. This risk has to be balanced against the morbidity of a more extensive surgical repair and bypass. With our operative setting, we find the surgical treatment involving re-establishment of arterial continuity by direct re-anastomosis or bypass technique to be preferable. The main indication for surgery is prevention of permanent neurological sequelae arising from thrombo-embolic events. Haemorrhage from spontaneous rupture is rare.

The operative technique reported here is based on that described by Purdue.[8] However, when the aneurysm extends all the way to the base of the skull, as in our cases, gaining access to a normal artery wall distal to the aneurysm necessitates intrapetrosal exposure of ICA. Alternatively an extracranial–intracranial bypass could be performed. As the patency of a graft is inversely correlated to its length, we opted for the shortest possible route, i.e. exposing the intrapetrosal ICA as an addition to the Purdue technique. This approach has a limited price in terms of postoperative morbidity. Hearing can be preserved and facial nerve function will return. Also in patients tolerating test occlusion, a sacrifice of the ICA is a small risk for stroke, and we therefore recommend reconstruction of the artery in every case. With sacrifice of one ICA there is also an increased risk for developing intracranial aneurysms over time, due to the increased haemodynamic load on the circle of Willis. Rupture of such aneurysms carries high mortality and morbidity.

Patients not tolerating test balloon occlusion are at risk for stroke even during brief occlusion periods. A neuroprotective regimen including moderate hypothermia, mannitol and barbiturate effectively protects the brain from ischaemic infarction and in the one patient of ours at risk we relied on this strategy exclusively. We also opted to add an intracranial exposure of the ICA to allow for a rapid alternative

bypass route, if this would have been necessary. An external carotid-to-middle cerebral artery bypass performed as a separate procedure some weeks before the aneurysm surgery might be an alternative to the intraoperative neuroprotection.

Our experience with this rare operation is gratifying with excellent long-term results. By utilising the specific surgical competence from the different subspecialities involved in the team, we believe that this complicated procedure can be done with the highest possible safety in spite of limited experience of individual surgeons.

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